

# The Halting Problem

## The Halting Problem

Given: source code for a program  $P$  and  $x$  an input we could give to  $P$   
 Return: True if  $P$  will halt on  $x$ , False if it runs forever (e.g. goes in an infinite loop or infinitely recurses)

This would be super useful to solve!

We can't solve it...let's find out why.

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## A Very Tricky Program.

```
Diagonal.java(String x){
    Run H.exe on input <x, x>
    if(H.exe says "x halts on x")
        while(true){//Go into an infinite loop
            int x=2+2;
        }
    else //H.exe says "x doesn't halt on x"
        return; //halt.
}
```

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## What this does and doesn't mean

Does this code halt?

```
public static void main(String[] args)
{
    int i=0;
    while(i<100){
        System.out.println("*");
        i++;
    }
}
```

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## A Reduction

```
Trick(P,x){
  Run P on x, //(but only simulate printing if P prints things)
  Print "Hello World"
}
```

This actually prints "hello world" iff P halts on x.

Plug Trick into W and....we solved the Halting Problem!

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